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**Interactive
comment**

Interactive comment on "Lower-tropospheric CO_2 from near-infrared ACOS-GOSAT observations" *by* Susan S. Kulawik et al.

Anonymous Referee #1

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This paper presents a method of extracting two useful pieces of information from the ACOS retrieval of GOSAT spectra: a lower-most tropospheric partial column (LMT, 0-2.5km), and remaining partial column above (U, above 2.5km). This work represents a new, novel data product that will be useful for carbon cycle scientific studies. I recommend this paper for publication after several comments are addressed.

General Comments:

Section 4.5: The authors discuss extending the profiles above the aircraft ceiling, and then later they discuss the errors arising from this unmeasured region. AirCores, which measure from near the surface up to 20-30km, have been made at the SGP, in Sodankyla, in Boulder, and in Lauder (as well as other places). Could those measurements be useful in this discussion? Could they at least be useful to test whether

extending the top aircraft measurement through the tropopause and tacking on Car-bonTracker above is indeed a sensible thing to do?

P13L516: It doesn't seem reasonable to me to use a free-tropospheric temperature coincidence criteria (such as in Wunch et al. 2011), which uses 700 hPa ($\sim$3 km) temperatures for coincidences for the LMT or U partial columns. If I look at Figure 3, I see that the XCO_2 sensitivity at 700 hPa is very high, but this is not the case for either U or LMT. The free-tropospheric temperature coincidence criteria exploits the sensitivity of the XCO_2 to the free troposphere. The LMT and U are explicitly unraveling this sensitivity. Perhaps this could lead the authors to more robust "dynamical coincidence criteria" for their two new products.

P6L253: Please discuss the implications of the fact that neither LMT nor U have a full DOF.

P33L1329: Please comment on the seemingly contradictory information that the strongest bias is related to delta_grad_CO2, which seems to be a measure of how oscillatory the retrieval of the CO_2 vertical profile is, yet you are able to extract sensible LMT and U partial columns from the data.

Technical Comments:

In general, there are too many acronyms, the most confusing to me were: ct_ct, the site location acronyms, etc. Please simplify if possible.

The results section contains too many numbers that are already listed in the tables (especially sections 5.1.1, 5.1.2, 5.1.4, 5.1.5). Please include only the most important numbers in the text, especially when the numbers are already in tables and figures.

The figure descriptions are too detailed in the results section. For example, only the figure captions should contain the detailed color, line style, and marker information.

P1L24: Does LMT stand for "lower-most troposphere"?

P2L50: Define TCCON here, as it's the first mention of it.

P3L125: Mention that you use only high gain GOSAT data, if that is indeed the case.

P4L145: "... best matches the satellite overpass" –> do you mean it best matches the overpass *time*?

P4L151: at –> within

P4L170: Is the "15" in this line spurious?

P6L227: TCCON's focus isn't solely on validation.

P6L249: which may be chosen *to* constrain. This sentence as far too many instances of the word "constrain".

P12L489: Missing something in parentheses ().

P14L579: "... the biggest detriment of use of..." –> consider rewording

P15L601: I assume this -2ppm change is at the surface, and not throughout the (partial or total) column?

P16L684: Where should the parentheses go? There is only an open bracket in both equations (11) and (12).

P19L778: The paragraph ends mid-sentence. What is the multiplication factor over ocean?

P22L926: Measurements *of* CO2 *at* 4 km and 1 km.

P24L999-1001: This second sentence of the paragraph seems redundant with the first.

Figure 4, 5, 7, 8: I don't understand the legends. For example, in Fig 4, the red dashed curve isn't the difference between LMT and XCO2, is it? Please clarify and simplify the legends.

Figure 7(f): Expand the lower limit of the y-axes so we can see the seasonal cycle

minimum from GOSAT LMT.

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Discussion paper